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Scaffolding Advice on Task Selection:

A Safe Path Toward Self-directed Learning in On-demand Education

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Abstract

An intuitively appealing approach to flexibilisation of vocational education and training is to delegate choices on instruction, such as the selection of learning tasks, to students. However, empirical evidence shows that students often do not have sufficiently developed self-directed learning skills to select suitable tasks. This article describes the Informed Self-Directed Learning (ISDL) model, which depicts three information resources supporting students' process of task selection and helping them to develop important self-directed learning skills necessary for effective task selection: (1) a structured development portfolio to support and develop their self-assessment skills, (2) a description of task metadata to help them compare and select suitable tasks, and (3) a protocol for giving advice, which explicitly demonstrates how to use performance results to select suitable tasks. Furthermore, the ISDL model proposes that as students further develop their self-directed learning skills and improve their task selections, the frequency and/or level of detail of given advice gradually diminishes and the number of available tasks to choose from increases.

Keywords: self-directed learning; on-demand education; development portfolio; advice

1. Introduction

Competence-based learning is the new paradigm for innovations in Vocational Education and Training (VET) programs (Biemans et al. 2004). In competence-based VET programs, students develop complex skills or professional competencies by working on authentic learning tasks. Such tasks help students to integrate the knowledge, skills, and attitudes necessary for effective task performance, facilitating transfer of what is learned to future work settings and daily life (Merrill 2002; van Merriënboer, & Kirschner 2001). However, competence-based education might easily overwhelm students because of the complexity of the learning tasks, which may negatively influence learning and motivation (van Merriënboer, Kirschner, & Kester 2003). Therefore, it is critical to adjust the difficulty and support level of learning tasks to the nature and amount of the students' available prior knowledge and current levels of performance. Giving students control over the selection of learning tasks they want to perform is an intuitive and appealing instructional method to address their individual differences.

In the Netherlands, on-demand education is increasingly introduced to address the individual differences between students. On-demand education is largely based on the idea of learner-controlled task selection. It is an educational approach in which students are given control over one or more instructional aspects such as order, pace, available support, and so forth. Through such learner-controlled task selection, students can match their own individual characteristics and preferences with the instructional features of the available learning tasks in the curriculum, enabling them to plan their own learning (Katz & Assor 2007; Williams 1996). The amount of control given to learners over one or more instructional aspects can vary from full control, via shared control, to no control at all. This article addresses on-demand education in which learners are given a high level of control over task selection and are given the opportunity to choose their preferred learning task(s) in order to develop the complex skills or professional competencies the educational program aims at. They choose these tasks from a large collection of predefined learning tasks, which differ in level of difficulty, level of support, and other authentic features (van Merriënboer 1997). For example, hairstylist students in an on-demand vocational training program may develop the skill of colouring hair by selecting learning tasks in any order from a set of predefined tasks. Each learning task can be categorised according to the combination of its level of difficulty (e.g., apply only one colour of hair-dye or several colours), its level of support given during task performance (e.g., expert observation, occasional help from an expert or no help at all), and other authentic features (e.g., performance with or without a time-limit, performance on a dummy hairdressing head or on a real model). Students are free to select any task, and to perform the tasks in any order they prefer.

Several cognitive, metacognitive, and affective learning theories provide sound arguments for the assumed positive effects of on-demand education on students' performance, intrinsic motivation, and development of self-directed learning skills. However, its effectiveness has not been established consistently by empirical research (Hannafin 1984; Levett-Jones 2005; Niemiec, Sikorski, & Walberg 1996; Steinberg 1977, 1989). One explanation for this finding is that the learning environment does not always take learners' underdeveloped self-directed learning skills into account (i.e., their inability to plan, monitor, and evaluate own performance), whereas well developed self-directed learning skills are prerequisite to function effectively in an on-demand educational setting (Biemans et al. 2004; Brockett & Hiemstra 1991). In on-demand education, the learning environment is often too open, providing students with too many choices and too little guidance or advice to help them make adequate task selections, because it is assumed that all students are already able to choose adequate tasks to improve their performance.

This can lead to negligible or even negative effects of on-demand education on cognitive (i.e., performance), metacognitive (i.e., self-directed learning skills), and affective (i.e., motivation) learning variables (Katz & Assor 2007; Williams 1996).

Because on-demand education is becoming more and more popular in VET, the main aim of this study is to determine how the effectiveness of on-demand education can be improved by adjusting the learning environment in such a way that it helps students to compensate for their poor self-directed learning skills and to further develop these skills. First, factors positively or negatively influencing the effectiveness of on-demand education are deduced from cognitive, metacognitive and affective theories, and from empirical research findings on learner control and self-directed learning. Second, these factors are translated into mechanisms that must be supported by on-demand education and be available for students to guide them during their task selections, and help them to eventually develop their self-directed learning skills. Next, the Informed Self-Directed Learning (ISDL) model is proposed, which includes and combines these mechanisms. The model is based on the idea of providing students with sufficient and structured information in the form of a development portfolio, task metadata, and advice, to support the development of their (initially poorly developed) self-directed learning skills during a cyclical process of task selection. In addition, the model shows how scaffolding might be designed to help students development their self-directed learning skills themselves. Finally, main conclusions and directions for future research are presented.

2. On-demand education: effectiveness and directions for improvement

Theories on cognitive, metacognitive, and affective learning activities provide a sound basis to understand the potential effectiveness of on-demand education. Using these theories to interpret previous research results, factors are deduced that either positively or negatively influence the effectiveness of this educational approach. In the next sections, the three theoretical perspectives and empirical findings are discussed and integrated with each other. Subsequently, implications for the design of effective on-demand education are formulated.

2.1 Cognitive perspectives on learner control over task selection

Many cognitive theorists argue that providing learners with control over task selection positively affects the quality of their cognitive learning activities because it enhances the processing of new information (e.g., Gagné 1985; Hartley 1985; Merrill 1994; Reigeluth & Stein 1983; van Merriënboer, Clark, & de Croock 2002). According to information processing theory, learners use several encoding strategies to organize and integrate new information in previously constructed cognitive schemata in memory (Gagné 1985). Providing students with control over task selection, over sequence, and over contents gives them the opportunity to choose and apply an encoding strategy that helps them to encode and store information in a personally meaningful way, which is best attuned to schemata already available in memory (Hartley 1985; Milheim & Martin 1991). This gives students the advantage to construct richer and more integrated schemata which eventually enhance the retrieval process and, thus, the transfer of what is learned to new problems and situations (Hooper & Hannafin 1988).

Besides these positive effects, cognitive theorists also point out and warn for the negative effects learner-controlled instruction might have on learning outcomes and transfer. Gagné (1985) states that the sequence in which learners encode new pieces of information is critical, because this influences how they integrate the new information and gradually construct a representation of the domain. Because on-demand education gives students control over the sequencing of learning tasks, this might undermine the structure that is inherent to the learning domain, thus negating its effectiveness.

Research on learner-controlled instruction confirms the existence of negative effects learner control over task selection, showing that learners are not always capable of making substantiated, appropriate, and effective selections of learning tasks (e.g., Clark 1989; Steinberg 1989; Williams 1996), resulting in poor sequencing of information and, consequently, ineffective learning and low transfer of learning. Two cognitive factors responsible for ineffective task selection are absent or little prior knowledge, and incorrect prior knowledge of the domain. Students with absent or little prior knowledge are not sufficiently familiar with the domain, material, and task features to reason which tasks can best help them to construct or reconstruct their cognitive schemata in a meaningful way: If you know little about a domain, it is very difficult or even impossible to select the most suitable learning tasks. Furthermore, if students have incorrect prior knowledge (e.g., misconceptions, naïve mental models), their misconceptions of tasks' relative difficulty level or required skills to perform them, make them prone to choose tasks that are either too difficult, too easy, or irrelevant for the schemata they need to construct (Anderson 1990; Gray 1987; Ross & Rakow 1981; Ross, Rakow, & Bush 1980).

Several researchers suggested already two decades ago that learner-controlled instruction that regularly informs or advises learners, provides them with an aid to make effective decisions by counteracting the negative effects of little or incorrect prior knowledge (e.g., Hannafin 1984; Milheim & Martin 1991; Steinberg 1989; Tennyson & Buttery 1980; Tennyson, Tennyson, & Wolfgang 1980). Especially information on features of to-be-selected tasks (i.e., *task metadata*) is important for students who are novices in a domain. Students should be familiarized with relevant task characteristics, like topic or focus of the task, its level of difficulty and support. In addition, students should be informed on the optimal sequencing of tasks, and should be explained that in order to learn a complex skill or professional competency, one should start with tasks that are relatively easy and first learn the basic skills, smoothly progressing toward more difficult tasks and more complex skills (van Merriënboer 1997).

2.2. Metacognitive perspectives on learner control over task selection

From a metacognitive perspective, learner control over task selection is assumed to have positive effects on the development of students' self-directed learning skills (e.g., Brockett & Hiemstra 1991; Williams 1996; Zimmerman 1994). Moreover, exercising control over one's own learning is conditional for self-directed learning (Merrill 1975, 1980), including the planning of new learning tasks, the monitoring of task performance, the assessment of results, and the formulation of learning goals (Knowles 1975, 1986). Giving learners control over task selection, as in on-demand education, might induce more elaborate mental processing in students as a result of the deliberate choices they have to make (Salomon 1983, 1985). Zimmerman (1994) even argues that if students are not allowed to take control over their own learning, they are not likely to develop effective strategies for self-regulation. Thus, from a theoretical perspective, a certain amount of responsibility for own learning seems to be a conditio sine qua non to become a self-directed learner.

Paradoxically, empirical results show that self-directed learning skills are not only a positive result of giving control over task selection to learners, but also a minimum requirement to handle the control that is being delegated (Clark 1989; Hill & Hannafin 2001; Land, 2000). Thus, there is a chicken-and-egg relation between the two. To enable students to develop their self-directed learning skills they should be given control over task selection, but at the same time these skills should already be developed to some minimum level to prevent students from negative effects of being for the first time in control of their own learning.

Students are better able to make effective task selections, if they know their strengths and weaknesses (Sadler 1983). However, inexperienced self-directed learners and students with a low level of expertise or little prior knowledge have poorly developed self-assessment skills, insufficient knowledge of performance standards (i.e. criteria, values, attitudes), and *do not know what they do not know* (Williams 1996; Wydra 1980). This makes these students prone to base their decisions on a subjective, distorted perception of their learning (Bjork 1999; Tillema 2003; Tousignant & DesMarchais 2002), resulting in inappropriate task selections or ending practice too early, because they believe to have reached the desired goals.

Furthermore, students often are not able to formulate learning goals effectively, that is, they do not formulate goals in terms of target behaviour, conditions, and criteria (Mager 1962), or as SMART goals (i.e., Specific, Measurable, Attainable, Realistic, Timely). The poor specification of goals inhibits students from selecting systematically their tasks and work deliberately on improvement of their performance.

To help students make appropriate task selections, they need to be regularly informed on the quality of their task performance and/or the performance standards and the degree in which they have reached those standards (Tennyson & Buttery 1980). This information helps them to determine which aspects of their performance need improvement (i.e., do not yet reach the performance standards). This, in turn, provides useful information for determining the level of difficulty, available support, and other authentic features of the next learning task(s) they have to select. However, informing students on the quality of their performance by an external source only (e.g., teacher, computer program) does not automatically contribute to the development of their self-directed learning skills: Students should also learn to inform *themselves* on the quality of their performance and their learning goals.

To help students make increasingly more accurate self-assessments and induce effective learning goals from these assessmentsstudents should be provided with instructional guidance and need to be better informed (Bell & Kozlowski 2002; Birenbaum & Dochy 1996; Tillema 2003). This information might refer to performance standards that must be reached, videotapes or other recordings that may be studied in order to compare and contrast current performances with previous performances, assessments conducted by peers or experts (e.g., teachers, employers) that allow for comparisons with self-assessments, and so forth. In addition, students' self-assessment skills might be supported and developed by providing them with structured tools that help them to systematically plan, monitor, and assess their performance. In this way, students are supported in creating a more realistic view of their strengths and weaknesses. In addition, after gathering the information on their performance students need to be advised on how to formulate effective learning goals (e.g., using the SMART acronym). Together, these information elements provide students with a sound basis for task selection.

2.3. Affective perspectives on learner control over task selection

A third theoretical perspective helping to explain the effectiveness of learner-controlled task selection is provided by theories on the role of affect in learning. Perhaps the most obvious (or at least most cited) framework to understand the potential effectiveness of learner control is provided by Milheim and Martin (1991): motivation. Motivation can be defined as the degree to which students are willing to invest time and effort in their learning processes (Keller 1983). Several principles can be identified that develop, sustain or forestall motivation. Motivation to learn almost naturally occurs in situations where learners perceive the learning process to be interesting, personally meaningful and relevant, and where the instruction allows for autonomy of learning (Deci & Ryan 1985; McCombs & Whisler 1989; Ryan & Deci 2000). Giving learners control over task selection clearly addresses the principles of autonomy and relevance. Students experience autonomy by the freedom to choose whatever task(s) they prefer. This freedom enables them to match instruction with their personal goals, which makes instruction more relevant and personally meaningful. This feeling of autonomy and relevance is expected to increase their motivation to learn, with positive effects on performance.

Paradoxically, students who are given control over task selection may also perceive it as a *burden of choice*, yielding negative effects on their motivation. When making complex decisions, people might become overwhelmed by the freedom of choice and experience the given control more like a burden than a privilege (Schwartz 2004). Students in on-demand education are also provided with a wide range of choices of which they have to continually assess whether or not they are worth to select, which might result in a feeling of cognitive overload (Roselli 1991).

In order to counteract this feeling of cognitive overload or burden of choice, students should be provided with detailed and structured information on the characteristics of the learning tasks they can choose from (Schwartz 2004). Detailed information on tasks' level of difficulty, support, and/or topic (i.e., what will you learn from it?) can help to reduce the complexity of the task selection process. These information elements help students systematically cancel out tasks that are not worth selecting, because they do not match with their current performance level or learning goals. Besides providing students with detailed task metadata, the number of tasks students can choose from may also be varied, according to the level of their self-directed learning skills and their prior knowledge of the domain.

Another factor that may negatively influence students' motivation and performance is a feeling of incompetence. The need for competence is an important factor that enhances motivation (Ryan & Deci 2000), and a feeling of competence has positive effects on performance (Bandura 1986). Giving students control over task selection can threaten their feeling of competence with respect to task performance and/or task selection. A feeling of incompetence may, for instance, result from the fact that students with a limited ability to judge their own performance base their task selections on biased information. This increases the chance that they select tasks that are too difficult for their actual skill and/or knowledge level, which, in turn, negatively influences task performance and hence their feeling of competence. A feeling of incompetence might also result from the fact that students have not experienced responsibility for their own learning before. This may result in the development of a negative attitude toward on-demand education which in turn negatively influences their motivation and performance (Clark 1989). When giving learners control over task selection, it is thus of utmost importance to create positive feelings of competence and attitudes toward this educational approach, because the affective variables are important drives for continuing participation in the training program.

Students' feeling of competence for task selection could be enhanced by informing them on the performance standards, on their progress, and by providing them with information on the relative difficulty level and the amount of support provided by the learning tasks they can choose from (i.e., the task metadata). In this way, students confidence and feeling of competence is enhanced because they, respectively: (a) know what is expected of them (b) may create a realistic view of their performance level, and (c) are less prone to choose tasks that are too difficult, which increases the probability to experience success (Keller 1983). In addition, students' feeling of competence for task selection may be maintained if they are guided in their task selection process by an expert (e.g., teacher, supervisor) who provides advice on the choices they make. The advice does not only prevent them from making wrong choices, but also functions as an example from which students can learn and develop task selection skills, which will eventually make them feel more competent to effectively select learning tasks.

2.4. Combining the three perspectives

Integrating the three frameworks it can be concluded that, in general, the different perspectives support on-demand education because it might enhance the learning process and learning outcomes, either directly or indirectly via cognitive, metacognitive, and affective mechanisms. At the same time, these theories point out the necessary conditions that have to be met by the learning environment for on-demand education to be effective. Many empirical studies on learner control, examining a variety of cognitive, metacognitive, and affective variables (e.g., attitude, prior knowledge, anxiety, self-directed learning skills) in combination with different levels of control, confirm these theoretical precautions (Hannafin 1984; Ross & Rakow 1982; Snow 1980). Effective on-demand education yielding positive effects on these learning variables needs to support students in the development of their self-directed learning skills: Their ability to monitor task performance, assess learning outcomes, diagnose learning needs, formulate learning goals, and select and plan learning tasks (Knowles 1975). To realize this, the learning environment must be structured, transparent, and informative to students, by providing them with specific information enabling a continuous process of assessment, task selection, and performance improvement (Tennyson & Buttery 1980).

From a cognitive perspective, this information relates to the quality of students' performance (Reigeluth & Stein 1983) and the metadata of the learning tasks they can choose from (Steinberg, 1989; Williams 1996). From a metacognitive perspective, it is important to inform students on the assessment of others (e.g., peer, trainer), the performance standards, and how to formulate learning goals. Taking an affective perspective, the information provided to the students should concern information on their progress and detailed metadata of available tasks. However, the information provided on performance, performance standards, and task metadata available in the learning environment might not be sufficient for all students to make adequate task selections. Therefore extra information should be provided to students to base their decision on, in the form of advice on task selection.

A distinction can be made between procedural and strategic advisory models. *Procedural models* provide straightforward advice on which task(s) to select and why, whereas *strategic models* explicitly help students to apply cognitive regulation strategies for assessing their own performance and matching assessment results with the characteristics of available learning tasks. Advice on task selection provides students with some form of support, which can actually hamper the full development of their self-directed learning skills. Therefore, on-demand education should apply a process of *scaffolding* (Rosenshine & Meister 1992), that is, a high level of support and guidance is given in the beginning of the educational program (e.g., a teacher assesses performance, a small set of tasks and their metadata is provided to choose from, detailed advice on task selection is given), but support and guidance gradually diminish as students further develop their self-directed learning skills (e.g., learners self-assess performance, a large set of tasks and their metadata is provided, and no advice on task selection is given). Ideally, students need no advice anymore before the end of the educational program because they have eventually become self-directed learners. In addition, these scaffolds can be adapted to the individual needs of each students, because students differ in their ability to self-direct their learning (Snow 1980; Williams 1996).

Combining the three perspectives, it becomes clear that in order to help students to effectively use the control they are given in on-demand education, the learning environment needs to become more informative (i.e., provide students with specific information). The findings resulting from the combination of the three perspectives findings can be converted into mechanisms that should be available in the learning environment in order to enhance the effectiveness of on-demand education. These mechanisms are described in the ISDL model, which is explained in detail in the next section.

3. The informed self-directed learning (ISDL) model

< Insert Figure 1 about here>

Based on the three theoretical perspectives described above, the ISDL model depicts how the cyclical process of self-directed task selection in on-demand education is made more effective by including three information resources to inform students. In Figure 1, the resources are positioned within the large arrow: A development portfolio, an advisory model, and task metadata. The information resources aim to increase the effectiveness of on-demand education, which, according to our theoretical framework, is jeopardized by students’ lack of information conditional for a successful process of task selection. The inclusion of the advisory model is based on the empirical finding that students often have not yet developed their self-directed learning skills sufficiently, and need to be explicitly supported in the development of these skills. The information provided to the students by the development portfolio and task metadata is directly related to the activities and the corresponding self-directed learning skills that play a key role in the process of task selection: Self-assessment of performance, formulation of learning goals, and choosing learning tasks (Knowles 1975).

The next sections discuss how the three information resources should be designed in order to increase the effectiveness of self-directed task selection, both in terms of selecting more appropriate learning tasks and in terms of facilitating the development of self-directed learning skills.

3.1. Development portfolio

The metacognitive perspective on learner-controlled instruction stresses that students must be able to identify their strengths and weaknesses in order to choose one or more suitable tasks to work on, that is, to plan their future learning (Knowles 1975, 1986). A development portfolio is a useful tool for this purpose (see the document box in the left part of Figure 1) (Zeichner & Wray 2001). A development portfolio such as a learning portfolio (Zeichner & Wray 2001) or a process-folio (Seidel et al. 1997) contains a students' collection of artefacts indicating the development or lack of development of students' abilities. It is used for formative assessment purposes, prompting students to critically reflect on their performance and identify the cause of their weak performance. To help students assess their performance and identify their learning needs, a development portfolio has the following functionalities: (a) Provide an overview of conducted assessments, the student's current level of performance, and performance standards; (b) support systematic self-assessment as well as the development of self-assessment skills, and (c) support systematic task selection.

First, a development portfolio in on-demand education should provide students with an overview of their performance level, containing detailed information on assessments of previously performed tasks conducted by different assessors, such as teachers, peers, employers, computer systems, and students themselves (i.e., self-assessments). By combining assessments of these different assessors, students receive 360-degrees feedback on their performances, which is expected to better help them to indicate performance gaps between current and desired performances.

In addition, it is recommended that the development portfolio does not only provide students with an overall score (e.g., excellent, average, failed) on their task performance, but also informs them on constituent skills involved and their corresponding performance standards, in particular which aspects or constituent skills of their performance already do and which do not yet come up to the standards. For example, if hairstylist students create a coloured hair style they should not only receive an overall assessment, but should also be informed if standards (e.g., pace, precision, distribution) are met for different constituent skills such as advising, application of colour, washing, and shampooing, and if not, explain necessary points for improvement (e.g., colour is not washed out properly, hair-dye applied too slowly and not precisely). Furthermore, information on performance may be supplemented with information on invested mental effort, time spent on the learning task, and degree of independency while accomplishing the task (Salden et al. 2004). All this information helps students create a detailed overview of their performance level and insight in their strengths and weaknesses (Kluger & DeNisi 1996), which is important to formulate relevant learning goals, and select the most appropriate learning task(s) to fulfil their learning needs.

Second, the development portfolio should help students systematically assess performance and develop their self-assessment skills by providing, for each learning task recorded in the portfolio, an overview of (constituent) skills relevant for this particular learning task, as well as the performance standards relevant for the assessment of each (constituent) skill. This helps students to self-assess all relevant aspects of performance, taking the standards for acceptable performance into account. Besides using this pre-structured format, students should be given the opportunity to formulate the most important points for improvement in their own words. Because the development portfolio also contains assessments by others are in a position to critically compare these with their own assessments, and also learn from the assessment by others because they serve as “worked-out examples” (van Gog, Paas, & van Merriënboer 2004).

Third, a development portfolio should help students systematically select learning tasks and plan their learning trajectory. After having identified their learning needs, students often do not relate this information to selection of an appropriate task to fulfil these needs (Bell & Kozlowski 2002). By letting students use the same tool to support both reflection (looking back on performed tasks) and planning (looking forward to future tasks), performance assessment is explicitly related to task selection, which might make students more conscious of the relevance of (self-)assessments to improve their performance (Boud 1995).

Notably, the effectiveness of students’ selection of learning tasks, in the performance-assessment-selection cycle, is especially affected by the *repetitive* estimation of their level of performance (Flavell 1979). The use of a development portfolio will therefore have more positive effects on students’ task selections when it is used on a regular basis (i.e., if they are regularly informed on their progress). For instance, assessments are best gathered on a daily basis for *all* performed learning tasks, providing the best basis to plan the selection of future tasks. Furthermore, the daily assessments could be carefully analysed once a week to plan tasks to be performed in the upcoming week. Digital development portfolios are particularly useful for this frequent evaluations of performance levels, because they release students from many administrative and arithmetic duties. Calculations of mean scores, overviews of all tasks ordered by either difficulty level, topic, date, assessment criteria can be composed in only a few seconds. In order to reach a good match between the learning tasks they want to work on and their learning needs, students not only need information on their performance level but also information on the available tasks. This information is provided by task metadata.

3.2. Task metadata

In on-demand education, a—typically large—set of learning tasks is available for students to help them further develop their competencies. To select tasks that best match their learning needs, students should be informed on the metadata of these tasks (see the database at the right side of Figure 1) (Bell & Kozlowski 2002). These metadata should at least include the tasks' level of difficulty and support, the applicable performance standards, and prerequisite skills, knowledge, and attitudes to perform the task. Having these task metadata available, together with the information on their performance from their development portfolio, students are better able to match their needs with suitable tasks. Information on relative levels of difficulty and support also informs students on which learning tasks should be chosen to master basic competencies first before working on more complex tasks that aim at higher-level competencies.

Unfortunately, even when a development portfolio is used to inform students on their level of performance, and all critical task metadata are presented, not all students will be able to select suitable learning tasks. This is due to the fact that selecting appropriate learning tasks is a difficult aspect of self-directed learning, which must be learned by practicing it and receiving feedback on the quality of the selection process and the appropriateness of final selections. Providing students with advice has shown to be an effective method to help students make better choices and develop their task selection skills (Bell & Koslowski 2002; Tennyson & Buttery 1980).

3.3. Advice protocol

An advisory model (see the box between the development portfolio and the task metadata in Figure 1), combines the information from the development portfolio and the metadata of the available tasks into directions for task selection. The advice is composed of feedback and feedforward information. Feedback is provided on self-assessments and the formulation of learning goals, using the information from the students' development portfolio. Feedforward is provided in terms of directions for suitable learning tasks to select, combining the information form the development portfolio with the available task metadata. The advice may be either procedural or strategic in nature.

A procedural advisory model provides the students with feedback on their self-assessments skills and formulated learning goals, by informing them whether the self-assessments are in line with expert assessments and the SMART rules. Feedforward is provided by merely informing students which task(s) they could select in order to improve their performance. The directions for task selection are algorithmic in nature and do not provide any explanation of *why* particular task(s) should be selected. For example, in the domain of hairdressing, a student who performed poorly on colouring a person's hair and who wants to select an even more difficult task, might receive the following procedural advice: (a) "your own assessments are often more positive than the assessments of your teacher; (b) you formulate your learning goals too broadly, and (c) you are now advised to select task *x*, for which you have to apply hair conditioner as fast as possible on a dummy, without any help". She is not told that task *x* is advised because her poor performance was due to slow application of the hair-dye, and because this relatively easy task *x* gives her the opportunity to automatize the routine constituent skill of applying hair-dye.

A strategic advisory model provides the students with feedback on their self-assessments and self-formulated learning goals in terms of their accuracy and effectiveness, and provides directions for improvement of self-assessment skills (e.g., you might observe an expert who assesses the quality of task performance) and formulating learning goals (e.g., you should reformulate “try to work faster” as “complete the task within 15 minutes” , because the second goal is measurable). With respect to feedforward information, the directions for task selection are heuristic in nature and extend the basic information on suitable tasks with in-depth explanations and arguments for their suitability. A strategic model makes explicit how assessments of prior performance are interpreted and converted into directions for the selection of new learning tasks. The advice can, for instance, take the form of a modelling example (van Gog et al. 2004), showing an expert (e.g., teacher, supervisor) who is thinking aloud during the interpretation of a development portfolio in order to formulate directions for the selection of new learning tasks. To illustrate, the teacher may explain the hairstylist student that from an examination of her performance it becomes apparent that weaknesses in the skill of colouring hair are the pace of the application technique and the carefulness of the washing technique. Next, the teacher may explain that based on this information on points for improvement he searches for tasks that help enhance speed of application and/or washing technique. Then he explains how uses the task metadata helps him to find a relatively easy task (i.e., low difficulty level), without any support, in which the two indicated points for improvement can be practiced and assessed. Finally, the teacher explains that task *x*, in which the student has to apply hair conditioner on a dummy within 15 minutes, wash it carefully, and evaluate task performance specifically on duration and residual hair-dye, meets these demands and advises the student to select this task.

Alternatively, the strategic advisory model may take the form of a *process worksheet*, using a method of self-questioning and to guide the student through the conversion process from assessment results to directions for task selection. For example, students might have to answer questions like “Examine your performance - Which aspects of your performance are not sufficiently developed?”; “Which of these aspects should be improved first?”; “How can you improve the selected aspect?"; "What tasks could help you to improve these aspects?"; "What information do you need to choose these tasks?", and "Choose one task to improve your performance. Why did you choose this specific task?".

When a strategic advisory model is used, both the modelling-example and the process-worksheet approach explicitly help students to—learn—apply cognitive strategies for matching their assessment results with the metadata of the available learning tasks, making an informed selection from those tasks (Tennyson 1980). In addition, the information should be formulated and perceived as a non-binding *advice*: It can either be followed or neglected by the student. In this way, it will interfere less with students' own decision-making strategies, which diminishes the chance that advice has negative effects for students with more relevant prior knowledge or already better developed self-directed learning skills (i.e., it prevents "mathemathentic effects"; Clark 1989). In addition, the advice can be formulate less detailed or not formulated at all, if students have already sufficiently developed their self-directed learning skills.

4. Scaffolding in the ISDL model

If the learning environment adequately supports the development of students' self-directed learning skills, they eventually become self-directed learners who do not need elaborated advice anymore to make effective choices in various complex contexts and situations. As mentioned before, a promising approach to improving students' self-directed learning skills is scaffolding, (Rosenshine & Meister 1992). In the ISDL model, two approaches to realize scaffolding are distinguished: (a) A gradual increase in the number of learning tasks to choose from (indicated by the sliding calliper below the task box in Figure 1), and (b) a decrease in frequency and level of detail of the given advice on the process of task selection (indicated by the sliding calliper below the advice box). The next sections discuss these two approaches to scaffolding.

4.1. Increasing the number of tasks to choose from

In on-demand education, allowing students to select one or more learning tasks from a large database of tasks (e.g., dozens or hundreds) may lead to stress, high mental effort, and demotivation (Iyengar & Lepper 2000; Schwartz 2004). This may be explained by the fact that students have often not yet developed the necessary skills to effectively reduce the total set of tasks to a smaller selection of potentially appropriate tasks, from which one or more suitable learning tasks may then be selected. To scaffold students' task selection process, a teacher, expert or other intelligent agent could make a pre-selection of suitable tasks from which students can subsequently make a final selection (Corbalan, Kester, & van Merriënboer 2006). This allows students to develop their task selection skills in relatively simple and 'safe' situations. The optimum number of pre-selected tasks should gradually increase as students further develop and improve their task selection skills, as registered in their development portfolio. Students with better developed self-directed learning skills should be given a larger set of learning tasks to make a selection from than novice students. In Figure 1, this relationship is indicated by the arrow that runs from the development portfolio to the sliding calliper below the task database (ranging from 1 to *N* tasks to choose from).

4.2. Diminishing the frequency and detail of advice

Even when the number of learning tasks students can choose from is limited, they may encounter difficulties in the process of task selection. As discussed, advice on task selection may provide students with direction. However, eventually students have to make the task selections themselves, without any advice. The frequency and the level of detail of the advice should therefore gradually diminish, which allows students to improve and develop their task selection skills in a smooth fashion. The scaffolding of advice can be realized in two ways: By diminishing the level of detail of the advice, and by decreasing the frequency of providing advice. The level of detail of the advice may, for example, be decreased by first giving advice for performing the assessments, formulating the learning goals, and selecting new tasks; then for formulating the learning goals and selecting new tasks; then only for selecting new tasks, and finally not giving advice at all. The frequency of giving advice can be varied in two ways. First, the frequency may diminish according to a fixed rate. For example, during the first three weeks of the training program, students receive daily advice; during the next six months, students receive weekly advice, and during the remaining period, students receive monthly advice. Second, frequency may decrease in accordance with an increase in the quality of students' self-directed learning skills, as recorded in the development portfolio (i.e., adaptive frequency).

In the ISDL model, the process of scaffolding is depicted by a sliding calliper that works in two directions. Thus, the number of tasks to choose from can increase, but it can also decrease again if a student's task selection process becomes problematic again. Similarly, the level of detail and frequency of advice may increase again, if students appear not to be able to select appropriate tasks when given less advice. In addition, the amount of tasks and the frequency/detail of advice can decrease and increase independently of each other. For example, allowing students to choose from a larger amount of tasks and at the same time give them less detailed and frequent advice, may overwhelm them. Therefore a larger amount of tasks to choose from is better coupled with an increased or unchanged level of detail and frequency of advice, to help students first adjust to the more complex situation. After some time the advice could be given less frequently and be formulated less detailed. When students are able to select from a set of tasks with a given size without receiving advice, they might be given a larger set to choose from, but are also given advice again. This cycle continues until students are able to select from a theoretically unlimited amount of tasks without receiving any advice.

5. Discussion

This article described the ISDL model, which specifies how on-demand education can be designed in such a way that students are provided all necessary information and are adequately supported to exert control over the selection of learning tasks in an effective way. The mechanism presented in the ISDL model are based on cognitive, metacognitive, and affective explanations for the positive as well as the negative outcomes of self-directed learning and learner control, as reported in the literature. According to the model, the cyclical process of self-directed task selection will be more effective if students are enabled to make informed task selections, because they have the disposal of a development portfolio, metadata of available tasks, and advice on which tasks would best match their learning needs and why. After one or more tasks have been selected, students perform them and update their development portfolio with self-assessments and/or assessments from others. Because students eventually need to become self-directed learners, who make effective task selections without support or guidance, the amount of learning tasks they choose from should gradually increase, and the frequency and level of detail of the given advice should gradually decrease.

Future research needs to provide more insight into the specific effects of the information resources and their combined effects on cognitive, metacognitive, and affective learning outcomes. This research can be both experimental and quasi-experimental in nature. Highly controlled, experimental research in artificial settings is needed to examine the effects of variations in content and design of the information resources on students self-directed learning skills, aimed at further theory building and to allow for generalisation and standardisation of findings. Quasi-experimental and evidence based research in realistic environments which are complex and multi-factorial, can provide more insight in other factors and interacting forces that influence the effectiveness of the ISDL model. The outcomes of both types of research contribute to the theoretical base and effective implementation of the ISDL model (Norman & Schmidt, 2000).

With respect to information on performance levels gathered by self-assessments and assessments by others, relevant research questions concern the optimal way of presenting performance levels and performance standards to students, approaches to modelling and peer-assessment, and characteristics of assessment methods that help students reliably judge their own performance (e.g., ranking, videotaping). Regarding the task metadata provided to students, it needs to be examined which metadata are sufficient and necessary for students to make appropriate decisions and how those metadata should best be presented (e.g., when, how often, mode of presentation).

Finally, with respect to advice, research should provide more information on how advice is best formulated and presented to students in order to help them perform the process of task selection independently and adequately (Higgins, Hartley, & Skelton 2001). Different students need different types of advice. Some students need detailed and structured advice, whereas others profit more from global advice and self-questioning techniques. Future research might focus on the effects of different forms of advice on students' task selection skills, taking into account both short term and long term effects as well as different student characteristics. Research on students' and experts' reasoning during the interpretation of development portfolios on behalf of task selection (i.e., converting assessment results into directions for task selection) may also be an effective approach to find out which information resources, what kind of information, and which cognitive processes are (in)correctly used by students when they select one or more new learning tasks. The scaffolding of the procedural and strategic advice also needs to be examined in future research, exploring the different effects of providing students with a modelling example or with process worksheets. This research might especially focus on measurement that indicate when guidance can diminish and what kind of advice should be provided during the phases of scaffolding. The outcomes of such studies can yield more specific guidelines for the improvement of students' task selection process.

A particularly important issue in on-demand education which could be further investigated, is to acknowledge students' perceptions. Because students mostly come from a 'supply-driven' educational tradition, they may perceive the self-directed learning activities that are central in on-demand education, such as systematic self-assessment and independent task selection, as a burden or a superfluous external goal imposed by the educational system. This might negatively influence their motivation and, in turn, the effectiveness of the instructional approach because negative perceptions result in poor and externally motivated learning activities (Könings, Brand-Gruwel, & van Merriënboer 2005). Internalisation of the goals to direct one's own learning may counteract these negative effects. Promising ways to enhance this internalisation process should be investigated in future research.

Finally, for the experimental design of research on self-directed learning it is particularly important to control for factors that may invalidate the results and cause negative effects (Bell & Kozlowski 2002; Reeves 1993). In addition to student perceptions these concern time and setting. With regard to time, the duration of the treatment should be sufficiently long, because students do not develop self-directed learning skills on one single trial, but they need ample time to tune to the new educational approach and sufficient and regular practice to be able to develop and improve their self-directed learning skills. With regard to the setting, it is important to implement on-demand education in a whole curriculum or educational program rather than in only one or a few courses.

To conclude, we think that a common mistake in on-demand education is to assume that students who enter it already have well developed self-directed learning skills. Instead, it is better to assume that most of the students have not yet sufficiently developed these skills. Then, the learning environment should provide all relevant information and scaffold experiences to help students select their learning tasks and develop their self-directed learning skills. This is clearly reflected in our ISDL model: The mechanisms presented in the model aim to create a safe path toward on-demand education for all learners.

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Figure Captions

Figure 1. The Informed Self-Directed Learning (ISDL) model